THE TREATMENT OF COMPOUND FRACTURES WITH SPECIAL REFERENCE TO THE ORR METHOD*

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COMPOUND fractures have always constituted an important group of civil and industrial injuries. With the ever increasing number of automobile accidents, all surgeons are being called upon to treat more of these cases each year. The results at the present time vary all the way from brilliant to horrible, and any method recommended to the surgical profession at large should be one which the surgeon of average skill and experience will be able to carry out in the hospital of average equipment and personnel.

The methods of treating this group of injuries have varied from time to time with changing concepts of the treatment of infected wounds. In the early days of surgery compound fractures frequently resulted in death or amputation and whether this was done early or late depended on such factors as location, severity, hemorrhage or infection. From the adoption of antiseptic surgery the attention of surgeons has been primarily concentrated on the problem of handling infection in these cases. This undoubtedly worthy objective has, however, not always worked to the ultimate benefit of the patient, for, in concentrating upon the problem of infection, the fracture has been neglected. Too often one hears the statement that "we must forget the fracture and treat the patient." This is, of course, a most comfortable attitude for the surgeon to assume because it immediately relieves him of all responsibility for a bad result and places the burden on the Almighty. Of compound fractures Orr has said that the principles of orthopedic treatment have been sacrificed to the supposedly necessary but actually dangerous combatting of infection within the wound. With the introduction of the Carrel-Dakin treatment of wounds the ultimate in this point of view was achieved. No one can dispute the brilliant results that were obtained by the correct application of this method if our estimate is limited to a consideration of the infected wound alone, but neither can it be denied that it often disregarded the fracture. The infected wounds cleaned up and healed, but the records of the surgeon general's office show a disheartening number of patients still disabled on account of this disregard. Another objection to the Carrel-Dakin technic is its complexity and the demands that it makes for a highly trained organization. One gets the distinct impression that this form of treatment is losing favor and it is not at all uncommon to find interns, recently graduated from our best medical schools, who have never heard of it, or, if so, have never seen it used.

Diametrically opposed to the Carrel-Dakin treatment, we have the advo-

* Read before the American Surgical Association, Boston, Mass., June 7, 1935.

cates of immediate closure, with or without internal fixation. To Sherman, of Pittsburgh, must be given the credit for the advancement of this practice and in his hands the results seem to have justified his enthusiasm. The disastrous results in the hands of others not so preeminently qualified, however, would lead us to question the safety of recommending it freely and for situations different from those in which his successful results have been achieved.

Between these two extremes we find a great variety of practice. Cotton, writing in Lewis' Surgery, states that débridement, half closure, with drainage by leakage and delay of corrective surgery until later offer the best solution of the problem.

It would appear from this that there is little uniformity of opinion regarding the management of compound fractures. However, surgeons experienced in this type of work agree that all compound fractures are grave surgical emergencies requiring immediate operation. The nature of the surgery required is worthy of the best efforts of the mature surgeon and should not be delegated to inexperienced assistants. There are some who still attempt to differentiate between the fracture that is compounded from within and from without, claiming that the former is a wound made by a sterile instrument not requiring the same extensive exposure and débridement as the latter. We are in absolute disagreement with this point of view and regard it as a matter of academic interest only. It should also be emphasized that the external appearance of a wound is not a reliable criterion by which to judge of its internal extent. In one case, that of a fracture involving the ankle joint, the external wound was not more than an inch in diameter and yet after wide exposure a piece of stocking about three inches square was removed from the interior of the joint. In another case of fracture of the tibia, the external wound was apparently insignificant. A junior member of the department who saw the case reported by telephone that the wound was so slight that he did not feel justified in making a wide exposure, particularly since the fracture was in good position. The wound was disinfected superficially and plaster applied. The result was a virulent infection which nearly cost the patient his leg and his life. The extent of the internal damage disclosed at the second operation was most instructive. The patient fortunately made a good recovery eventually but only after prolonged hospitalization punctuated by repeated operations for the evacuation of pus.

In attempting to rationalize the treatment of compound fractures, Orr has stated four hypotheses upon which he bases his method. These are: (1) The use of antiseptics in the treatment of infected wounds has developed to the point of abuse. (2) It seems that it is not generally known that infected wounds do heal without the application of antiseptics of any kind. (3) Wounds if properly protected will heal consistently without daily dressings or irrigation with antiseptics in a way that is at once easier and better. (4) The important factors in securing these better results are: (*a*) Primary asepsis or antisepsis when required. (*b*) Adequate drainage. (*c*) Immobili-

zation of injured parts. (*d*) Protection of wounds against disturbance and reinfection.

It should be understood that the Orr method introduces no new principle in the treatment of compound fractures, but merely applies the well established principles of asepsis and immobilization in a somewhat different manner from that formerly recommended.

In the five years that we have been employing this method of treatment we have found it advisable to modify our original technic in some respects. Our present plan is as follows:

After the patient has been anesthetized, and not until then, the temporary splints and dressings are removed. A pad saturated with alcohol is laid over the wound and the entire extremity is shaved and then cleaned with ether and alcohol and painted with tincture of metaphen or iodine. The external wound is then accorded the same preparation.

A careful and systematic mechanical disinfection is then carried out, including excision of the wound margins, removal of all devitalized muscle and completely detached bone. Length and contour are then restored by traction and manipulation. The entire wound is then flooded with ether which often discloses bleeding points otherwise overlooked. The wound is next packed with sterile vaseline gauze, an important part of the operation. The packing should fill the entire wound. It should be placed in contact with the bone; the wound edges should be lifted up and the gauze placed beneath them. The gauze must be thoroughly impregnated with the vaseline and should be reasonably fresh. Gauze which has been repeatedly sterilized tends to become weak and upon removal individual cotton strands may be lost in the granulations and give rise to annoying residual infection of a low grade. Over the pack, vaselinized strips of gauze are laid clapboard fashion and an adequate pressure dressing of gauze and cotton is applied. A smooth, snug bandage covers the whole area. The limb is then immobilized by complete circular encasement in plaster of paris. No splitting or fenestration is permissible.

In fractures involving joints, this technic is modified in that the joint cavity, after thorough lavage with ether and particular attention to hemostasis, is closed with interrupted sutures of plain catgut. This plan was adopted in view of the impossibility of maintaining sterility of an open joint after dressings are finally begun. In cases where the joint has been closed we have had no trouble. The rest of the wound is packed as in the ordinary case.

The management from this point on is that of a closed fracture, no dressing being made for at least four weeks. In our earlier cases we kept our patients in the hospital until the first dressing was made. We now keep them in for one week. During the first few days there may be a slight elevation of the temperature (100°–102°) but this need cause no anxiety. It must be remembered that there is usually some temperature reaction following a simple fracture. If at the end of one week the temperature is normal, the patient is allowed to go home, returning in four to six weeks when the plaster case is removed.

In most instances the granulations will have pushed the packing up from the depths of the wound and one finds a clean, red, granulating surface with the bone completely covered. If there is a good firm base of granulation tissue, it is covered at once with pinch grafts. The grafts are covered with paraffin mesh and over this a pressure dressing of either rubber sponge or cotton is placed and held by adhesive strapping. Another plaster case is applied and no further dressing is made until union is complete. If skin grafting is not done at this time, the wound is simply cleansed with ether and covered with vaselinized strips of gauze and another case applied. This is the only dressing that is made until complete union has occurred. Occasionally one encounters difficulty with adult patients who become convinced that they are being neglected because they are not dressed. This dissatisfaction is augmented by visitors, who, unhampered by facts or information, regale the patients with gruesome tales of legs lost and so on. A little time spent in explaining the situation often prevents this sort of criticism. To overcome the odor, which is objectionable, various modifications have been suggested regarding the material used to impregnate the gauze pack. It can be helped but not prevented by using a gauze impregnated with both iodoform and vaselin, or by employing bismuth iodoform paste (BIPP). Thymol has also been suggested as a deodorant. The odor, of course, comes not from the wound but from the decomposing secretions in the unchanged dressings. It is a peculiar, highly characteristic smell, alike in all cases, and seems to indicate that the process is due to some specific factor or factors, as in the ripening of the various odoriferous cheeses. The liquefied secretion about the wound is dark, mucilaginous, and non-irritating to the tissues. We have not been able to attribute any of the effects of the treatment to the development of bacteriophage, though this has been suggested. It probably is not a matter of great importance what substance is used as far as the ultimate result is concerned and in the various published reports on this method probably a little too much emphasis has been placed on the vaselinized gauze. The important feature is that the mechanically disinfected wound is filled with a bland substance which will allow granulation to proceed and which prevents puddling in a wound covered with an occlusive dressing. We have adhered to the simple yellow vaseline gauze and encouraged the patients to endure the odor.

The convalescence of these patients is in marked contrast to those treated by the more familiar methods that required frequent dressings which not only were a source of dread to the patient, but which of necessity militated against adequate retention of the fracture and imposed the risk of superinfection. Our observations of compound fractures have led to the strong conviction that the suppuration which is so frequently seen is the result of infection introduced at these dressings. The following case is cited to illustrate this point:

CASE REPORT.—S. B., aged 50, a colored man, employed as a stevedore, sustained a compound comminuted fracture of the femur just above the knee joint, when a heavy packing case fell on him. In addition to the fracture of the femur he sustained a fracture

of the nose and maxilla and multiple lacerations of the face. He was in profound shock upon admission. The upper fragment of the femur was protruding through his overalls. After instituting measures for the relief of shock, the wound on the outer aspect of the thigh was flooded with iodine and covered with a sterile dressing. During the first 24 hours his condition was such as to warrant nothing beyond temporary extension in a Thomas splint. At the end of this time, under local anesthesia the wound was systematically cleaned out, the protruding bone replaced and the wound packed lightly with iodoform gauze. Tong extension was applied and the limb suspended in a Thomas splint from a Balkan frame in the usual manner. Plaster was not applied. The wound was not dressed and bedside roentgenograms at the end of the fourth day showed that the displacement of the upper fragment had been overcome and although there were 14 fragments present, the alignment was excellent. During the following three weeks the wound was not disturbed by any sort of dressing and the patient had no elevation of temperature. During the fourth week, a new house officer, becoming alarmed by the odor of the dressing, removed the packing, swabbed the wound with mercurochrome and repacked with plain gauze. On the following day the temperature rose sharply to 103° F. and from that point the patient was septic and developed an extensive cellulitis of the thigh which required multiple operations for relief. Union of the fracture, however, occurred but the infection in the depths of the wound prolonged hospitalization for many months.

The objections to the Orr treatment are based largely upon the hesitation almost instinctively aroused in any surgeon's mind as to the danger of encasing a presumably infected wound in plaster, and particularly the danger of anaerobic infection. Experience has demonstrated, however, that this fear is not warranted by the results and *a priori* objections must give way in the presence of facts. In our own case we were led rather easily to give the plan a trial because we had become convinced that prevailing methods, especially that of immediate suture, were dangerous or inadequate especially in wounds potentially contaminated with anaerobic organisms. We had been using with satisfaction open treatment with immobilization and it was not a violent break to employ vaselinized gauze as a pack and cover the wound for a longer period.

Anaerobic infection is certainly to be considered in any injury the result of a street or a farm accident and due precautions must be taken against it. While the incidence of tetanus appears to be on the decrease, in the Philadelphia area at least, we are seeing more cases of gas gangrene than formerly. A number of writers have drawn attention to this in the recent literature of gas gangrene in civil practice. Recognizing this danger in all compound fracture cases, whether treated by the Orr method or not, a prophylactic dose of the combined tetanus and gas serum should be given. Before the introduction of the combined serum we employed the two separately, first using the perfringens and later the polyvalent serum. The justification for giving gas or combined serum to these cases has been questioned by some surgeons on the ground that it was unnecessary, although those who question it do not hesitate to give antitetanic serum in all street injuries. It is admitted that in many instances this is an unnecessary precaution but it would seem quite as logical to give the combined serum as antitetanic serum alone.

Others advance the argument that wounds such as commonly accompany compound fractures should be dressed in a manner permitting frequent in-

spection and dressing, in order that proper measures may be applied to the infection which so frequently appears. The answer to this objection is that cases treated by the Orr method do not become infected and that wound infection and osteomyelitis are more often the result of meddlesome dressings than of original contamination.

It must be clearly understood that this method of dressing is not advocated in every case of compound fracture. In our experience it is not satisfactory in femur fractures. The femur lies in the center of a large muscle mass and it is not possible to place the packing in such a way as to prevent puddling in the tissues below and internal to the fracture. In these cases better results are obtained by dakinization combined with some method of suspension and traction. In "stripping" injuries it should not be used unless the wound is very widely opened. In the case seen late and presumably already infected it is usually contra-indicated. On the other hand in old compound fractures with non-union and low grade infection it may be employed with confidence as an adjunct to whatever method of fixation is elected. The following case is illustrative of this point.

CASE REPORT.—E. W., a man, aged 32, was admitted to Abington Hospital in September, 1934, giving a history of having sustained a compound fracture of the tibia seven months before. He had been treated in a fracture box and antiseptic dressings applied to the wound for a week. At the end of that time the fracture was plated and put up in a fenestrated case. Daily dressings were made. Infection, of course, set in, the plate loosened and came off. The attending surgeon then applied a larger plate and repeated the same after treatment with the same result. He then wired the fragments together. During all this time, daily or every other day, the wound was dressed. Finally, the patient was informed that nothing could be done for him and that his leg would probably have to be amputated. As he was a long way from home he elected to sign a release and enter a hospital in his own neighborhood for the operation. On admission he was wearing a fenestrated case. A wound eight inches long and two inches wide, sloughing, dirty and discharging pus was disclosed. In the wound the bone could be seen plainly, about four inches being exposed. The bone looked like a piece of coal, was denuded of periosteum and the fracture, a slightly oblique one, was held in place by a silver wire. There was no evidence of any attempt at callus formation.

Under general anesthesia the wound was excised widely, the wire removed, the ends of the bone freshed and the wound allowed to bleed itself full. When clotting had occurred it was covered with vaseline strips and a plaster case without fenestrations applied from the toes to the midthigh. No dressing was made for four weeks when the case was removed. The wound was clean and granulations were partially filling it. The bone, however, was not covered at all at the site of the fracture, but was of a better color. A second case was applied and the patient was allowed to go home the next day. Four weeks later, the wound was still clean but the bone was still widely exposed and no union had taken place. Full thickness graft six inches long taken from the opposite tibia was laid in after the Albee technic, the wound packed with vaseline gauze and the limb encased in plaster. In spite of the open and presumably infected field, the graft took and firm union was secured. The patient was dressed only twice during this period following the operation and is now walking with a brace without the aid of crutches. The wound healed nicely by granulation.

The conclusions reached regarding the management of compound fractures are based upon the following experience.

In a period of slightly more than five years we treated 203 compound fractures. We exclude those dying of associated injuries. Of these, 106 were treated by the Orr method. Of the 97 treated by other methods, three were partially closed and drained, two were immediately closed, and the remaining 92 were treated by wide open drainage and dakinization or simply by packing and immobilization. In the entire group there were five amputations. Two of these were in cases treated by the Orr method, one of these required amputation because of extensive damage to the blood supply and not on account of infection (amputation should have been performed at the time of the original operation); the other Orr case requiring operation developed generalized gas infection within 24 hours. This was a man with extensive crushing injuries to both the leg and thigh inflicted by a farm tractor. Owing to his condition no débridement could be done and several of the principles of the Orr method were violated. It was realized at the time that the treatment was unsatisfactory but it seemed that nothing else was immediately possible. The three remaining amputations were done as immediate procedures at the time of the first operation. In the entire group there were three deaths. One death was in the case just referred to; the other two occurred 24 and 48 hours after the injury and were due to hemorrhage and shock. With the exception of the two cases of amputation, we have not found it necessary to remove or open a single plaster case for infection. One case was recently removed at the end of a week in order to secure better position of the fracture but the packing was not removed and another encasement applied at once, the patient progressing to an uneventful recovery.

CONCLUSIONS

In the great majority of compound fractures, the Orr procedure is the method of choice.

The procedure is relatively simple and can be carried out under ordinary hospital conditions.

It is emphasized, however, that the essential conditions must be rigorously fulfilled and inability to meet them *in toto* may call for a complete change of plan.

The chief contraindication to the method, in our opinion, is the existence of extensive devitalizing injuries involving large muscle masses when adequate débridement is impracticable and complete immobilization difficult or impossible.

DISCUSSION.—DR. FREDERIC W. BANCROFT (New York).—Doctor Pfeiffer has brought up a very controversial subject in his paper on the Treatment of Compound Fractures. He has said there are three main methods of treating compound fractures:

(1) Leaving of the wound wide open, after careful débridement and treatment with Carrel-Dakin solution.

(2) Thorough débridement and closure, the closure being either primary or delayed, with the use of some intermediary treatment like Carrel-Dakin until the wound is bacteriologically clear.

(3) The Orr treatment.

Each one of these methods has its own advocates and each method has shown satisfactory results where good surgery is first performed and the postoperative care has been meticulously carried out. There is no doubt that the individual fitness and inclination of the surgeon, and the equipment and the personnel available for the after care, influence these results.

Doctor Pfeiffer in his summary states that in five years he and Doctor Smyth, Jr., have treated 203 cases of compound fracture: Of these 106 were treated by the Orr method and 97 were treated by other means. Of these 97, 92 cases were treated by wide open drainage and dakinization. I should like to ask Doctor Pfeiffer if the 106 cases treated by the Orr method have been consecutive and the latest cases treated or whether he uses selection in the type of cases. (I assume by his statement that compound fractures of the femur are not treated by the Orr method.) I feel this question is pertinent because it seems to me that there is sufficient good in each method of treatment so that one should not be an advocate of one sole procedure. The type of fracture, the location of the fracture and the amount of contamination that a compound fracture receives must be considered before deciding on the therapy. I do not believe that any one method is applicable to all types of fracture. The initial principles as set down by Orr should be the initial principles of any surgical procedure in the treatment of compound fractures. This means adequate and careful preparation of the skin and wound and adequate and careful débridement of devitalized tissues.

I am thoroughly in accord with Doctor Pfeiffer and many other surgeons that antiseptics are of little value in the treatment of lacerated wounds. I also believe that rough handling in the cleansing of wounds with soap and water and occasionally, as was previously advocated, with a scrubbing brush is also deleterious. Careful, painstaking, non-traumatic cleansing is the most important factor in the prevention of infection.

I must confess that I am astonished at the good results presented by Doctor Pfeiffer in his analysis of cases treated by the Orr method. The absence of infection and the absence of secondary operative procedure reveals good surgery carefully carried out. I also believe that he brings out a point which is very valuable in the early skin grafting of these cases; it unquestionably saves the patient weeks of incapacity and also disfiguring scars. Meleney has shown that one may apply pinch grafts within ten days after the removal of a gangrenous slough due to symbiotic infection. I have often wondered whether or not the odor that arises from the Orr treatment is not an indication of the therapeutic value of the therapy. The odor is said to be due to the action of the hay bacilli and other saphrophytic organisms. It is known that if these organisms contaminate a culture medium containing staphylococcus or streptococcus they rapidly overgrow these virulent organisms and cause their destruction. May it not be that the vaseline gauze and the plaster case which cause a good anaerobic medium stimulate the growth of these organisms which digest the offending pathologic bacteria? It has been my impression in treating cases with the Orr method that sometimes dressings are delayed too long for it is noted when they are removed that granulations have penetrated through the meshes of the gauze and considerable trauma is induced in their removal. I can see no harm, after a period of two weeks, in changing the dressing if it seems advisable. I am thoroughly in accord with Doctor Pfeiffer that if this method is started it should be continued through in the same manner unless there is some very strong contraindication. I believe that all of our infected wounds are dressed too often unless treated by the Dakin

method, which should be as described by Carrel—a thorough, non-traumatic cleansing.

In acute appendicitis associated with peritonitis it has been my custom for some time to leave the wound wide open and to pack it with vaseline gauze. This gauze is not disturbed for at least five days, assuming that there is no indication of local infection. The packing is then removed and the wound is again dressed with vaseline gauze inserted lightly. This is not disturbed for a similar period, when the wound is frequently almost healed.

I am thoroughly in accord with Doctor Pfeiffer on his treatment of compound femur fractures. Where the bone is so surrounded by deep muscular structures, it is very difficult to properly apply the Orr method, whether it be in compound fractures or osteomyelitis. I believe the results are as much due to good careful surgery as they are to the method applied.

DR. CALVIN M. SMYTH, JR. (Philadelphia).—The statistical matter in this paper perhaps requires a word of explanation. The majority of the cases in which the Orr treatment was not employed were those seen in the early days of our conversion to the method. As Doctor Pfeiffer said we had been for some time employing open drainage or packing combined with fixation and traction so that encasement in plaster was not such a radical change in our practice.

It has always been difficult to understand the reasoning of those who differentiate between the compounding of a fracture from within out and that from without in, and resting the decision as to immediate closure or open drainage upon this. Certainly, once the bone has protruded through the overlying soft parts and come into contact with the outside influences, contamination has necessarily taken place, and, as Doctor Pfeiffer has said, the matter becomes one of academic interest only. Neither can we who practice surgery in general hospitals receiving street accidents follow with confidence a plan which may work perfectly in a hospital which receives only cases from one or two industrial plants where everything is under perfect control and even the accident itself can almost be made to order. It is for this reason that we are so opposed to the practice of immediate closure.

What the Orr method offers is something which can be carried out in any well conducted hospital by any good general surgeon who will take the trouble to become familiar with the technic and follow it faithfully. We have employed it for a sufficient length of time and a wide enough variety of cases to have complete confidence in the method. We have talked about it in Philadelphia for a number of years and yet we still find a hesitancy on the part of our surgical friends to give it a trial. Curiously enough the most violent objectors to the Orr plan of treatment are found, not among the advocates of open methods, but among those who favor immediate and complete closure, and yet the objection that one hears most is that it is unsafe to leave these patients alone for four or five weeks. It was in the hope that more surgeons might be persuaded to convince themselves regarding the true worth of the procedure that this paper is presented today.

DR. DAMON B. PFEIFFER (Philadelphia).—I hope no one detected a belligerent note in our presentation of this paper, but if so, it comes perhaps from the fact that in spite of our intensity of feeling as to the merits of this method, we have been unable to secure anything like general approval or adoption in Philadelphia.

We presented this paper because we believe thoroughly that the method is a great advance in the treatment of compound fractures. There are three striking things that anyone who has followed this treatment will notice.

In the first place, the uniformity of healing without infection. No other plan with which I am familiar gives us the same security against infection as this procedure.

Second, the strikingly clean and excellent appearance of the granulations which cover bone and soft tissues on removal of the pack.

Third, the rapidity and uniformity with which union occurs in the lower third of the tibia, which is notoriously a site for slow union or non-union. We have yet to have an instance of non-union. As a general rule, union occurs much more rapidly than in ordinary closed fractures.

I have been stimulated to think about the reasons for the efficacy of this treatment, in the first place, because of the incredulity, if I may speak of it, of my colleagues, and in the second place, because one is naturally led to inquire about a phenomenon which is so impressive.

It seems to me, after all, the explanation is quite simple. All of our surgical wounds are contaminated. As surgeons, we must realize that bacteriologic asepsis is a very different thing from surgical asepsis. A Petri dish by the side of your operating table will soon convince you of that fact and while most of the organisms are saprophytes, some have pathogenic possibilities. We actually deal therefore with a dosage of infection, the amount of contamination. We rely upon such factors as blood supply, avoidance of puddling, dead spaces, avoidance of trauma, and we have come to regard our wounds inflicted under aseptic conditions as aseptic because they seem to heal aseptically.

These compound fracture wounds are practically never aseptic, but we reproduce, so far as I can see it in this method, the conditions of a wound inflicted under aseptic conditions. In other words, by débridement, we cut down the amount of infection. By introducing a pack impregnated with vaseline gauze, we prevent the pack from becoming a plug at once so that serum and blood can ooze out and in a very few hours every particle of that wound comes in contact with vaselinized gauze. All crevices are obliterated and complete immobilization is effected.

You have such organisms as are there imprisoned between the gauze and tissues, and the plight of a single or a few organisms in that situation, beset by the serologic and cellular forces of immunity, must be desperate. The wound thus completes its own sterilization. Every little while we have to rediscover the healing powers of nature, and this, I think, is what we are doing in this particular procedure.